AURORA AVENUE BRIDGE
(George Washington Memorial Bridge)
(Lake Union Bridge)
Aurora Avenue north (S.R. 99) spanning
the Lake Washington-Lake Union Ship Canal
Seattle
King County
Washington

HAER No. WA-107

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

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HISTORIC AMERICAN ENGINEERING RECORD
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Location:	Aurora Avenue north (State Route 99) spanning the Lake Washington Ship Canal (Lake Union), beginning at mile point 34.14, Seattle, King County, Washington
	UTM: 10/549100/5277710 10/549120/5276680
	Quad: Seattle North, Wash.
Date of Construction:	1932
Engineer:	Jacobs and Ober, Consulting Engineers, Seattle
Fabricator:	U. S. Steel Products Company of Seattle, steel superstructure; Pacific Bridge Company of Portland, main substructure; and N. Nygren of Seattle, approaches.
Owner:	Washington Department of Highways, since 1977 Washington State Department of Transportation, Olympia, Washington
Present Use:	Vehicular and pedestrian traffic
Significance:	The Aurora Avenue Bridge, a nearly 3,000-foot steel cantilever structure is one of Seattle's longest and tallest spans. It provided an important early crossing of the Lake Washington Ship Canal for motorists on western Washington's north-south motor route, the Pacific Highway.
Historian:	Robert W. Hadlow, Ph.D., August 1993

History of the Bridge

Fifteen thousand people gathered at the new Aurora Avenue Bridge in north Seattle on 22 February 1932 to witness its dedication as the George Washington Memorial Bridge. Sirens blasted as United States President Herbert Hoover symbolically opened the bridge with a golden telegraph key at the White House in Washington, D.C. Field artillery fired a twenty-one-gun salute, fire boats shot streams of water, and the Sixth Army Engineers Band played the National Anthem as the American flag was unfurled. Washington Governor Roland Hartley and Vancouver, British Columbia, Alderman W. H. Lembke sawed through a 62′ tall Douglas Fir tree symbolizing a ribbon cutting, with Mexican Consul W. P. Lawton keeping the saw blade well-oiled. Sons of the American Revolution members rolling back the barrier. Crowds moved forward like waves from both ends of the nearly 3,000′ structure. The ceremony was one of many scheduled in Seattle and across the nation during the bicentennial anniversary of George Washington's birth. The Aurora Avenue/George Washington Memorial Bridge opened as an important link in the Pacific Highway, western Washington's primary motor route that connected it with British Columbia to the north and Oregon to the south.[1]

Since the mid-1910s, Seattle residents saw a need for a high bridge over the Lake Washington Ship Canal, which provided passage for vessels travelling from Puget Sound and Lake Union to Lake Washington. The Fremont Avenue Bridge, a narrow two-lane double-leaf bascule draw span furnished a crossing for automobiles, but its design was a hindrance to smooth traffic flow as volume increased. A local citizens' committee began lobbying state lawmakers in 1925 to appropriate funds for a new high-level bridge. The Washington Department of Highways also promoted a new high-capacity bridge as part of establishing a dedicated route through Seattle for the Pacific Highway.[2]

The Washington State Legislature appropriated $1 million for constructing a bridge over the ship canal if both King County and Seattle would contribute $2 million. They agreed, and soon the director of highways, Samuel Humes, enlisted the local firm of Jacobs and Ober to investigate design possibilities and prepare final plans and specifications. Three design choices and four locations were narrowed to a long deck-cantilever structure on Aurora Avenue. All of them involved spanning the long, wide lowlands of the lake and canal northeast of Seattle's Queen Anne Hill. Looking for efficiency and economy in design, Jacobs and Ober decided between the simple truss, the suspension, and the

cantilever forms. The simple truss was the least expensive for moderate length structures, but the cantilever was more economical in longer bridges. A suspension span was seriously considered for the Aurora Avenue crossing, but poor foundations made it a costly alternative.[3]

Jacobs and Ober drafted plans for a nearly 2,955′ structure with a 800′ steel deck-cantilever span. The Department of War approved its shipping clearance, a point of contention among some captains of high-masted vessels. But the day of the tall ships had passed and the specifications were set at a minimum 135′ over a 150′ main channel. Soon construction began on the $4.5 million bridge.[4]

Design and Description

The Aurora Avenue Bridge became the second longest cantilever in the state, outdistanced only by the Longview Bridge, completed in 1930, on the lower Columbia River (HAER No. WA-89). The bridge, as originally built, read from south to north consisted of:

one 40′-10-7/8" reinforced-concrete deck girder span
one 63′-8-7/8" reinforced-concrete deck girder span
one 42′-5-7/8" reinforced-concrete deck girder span
three 75′ steel Double Intersection Warren trusses
one 200′ steel Warren deck truss
one 300′ steel deck truss anchor arm span
one 325′ steel deck truss cantilever span
one 150′ steel Warren deck truss suspended span
one 325′ steel deck truss cantilever span
one 350′ steel deck truss anchor arm span
one 225′ steel Warren deck truss
one 64′-3-7/8" reinforced-concrete deck girder span
five 63′ reinforced-concrete deck girder spans
four 57′-9" reinforced-concrete deck girder spans
two 42′ reinforced-concrete deck girder span
total structural length--2,954′-10-1/2"
total length of main steel spans--1,875′
total length of cantilever and suspension spans--800′
road deck, curb-to-curb--57′
--four 9-foot traffic lanes with 10′-5" shoulders
two 6′ sidewalks
deck thickness--6-3/4" inches or greater, reinforced-concrete

Silicon steel was heavily used in the structure to reduce tonnage but maintain optimum stress capabilities. Each one-ton reduction in weight, the designers believed, saved $70 on the project. All

major truss members consist of rolled riveted channel steel with lattice. Bracing consists of angle steel and lattice web. Longitudinal I-beams were used in the floor systems. The suspended span was joined to the cantilever arms by sliding pin joints. They were anchored to the main piers by fixed shoes with cast-iron pedestals. The central structure's sloped bottom chords permitted the use of shortened main piers while still attaining navigational height requirements in the canal's main and side channels.[5]

Pacific Bridge Company of Portland began excavations for the four central piers shortly after it received the contract in December 1929 for $502,274. The Department of Highways soon called for bids on the remainder of the bridge. The U. S. Steel Products Company of Seattle received the contract for the steel superstructure on 1 July 1930 for $1,247,888.[6]

Portland Bridge had difficulty in excavating and placing footings for the main piers. Foundations consisted of clay above the water level, and deep mud in Lake Union. The most time consuming part of placing the piers was driving cofferdams and excavating in the lake bottom and then driving 828 piles for the south main pier and 684 for the north main pier. Each timber was between 110' and 120' long. Shortly, tremie concrete for the two-columned batter piers, with segmental arched web walls, was poured from a floating plant.[7]

About 2,110' of the bridge is in steel spans, and for its entire length it runs at a 2.5 percent grade. The central portion of the structure is symmetrical in lengths except for the steel cantilever anchor arms. Clearance requirements at pier heads and permissible pier locations on land made the unbalanced spans necessary. Trusses over the main piers are 108'-6" deep and spaced 40' between center lines. Their panels throughout the cantilever spans ran a uniform 25'.[8]

Construction was carried out with travelling derricks for the cantilever anchor arms and spans. The bridge was completed by early 1932, with only the roadway approaches of a newly realigned Aurora Avenue yet to finish. Dedication came on Washington's Birthday, yet the bridge did not officially open for another five days. Some speculate that for this reason, it was never widely known by its christened name, the George Washington Memorial Bridge, and instead is referred to as the Aurora Avenue Bridge or the Lake Union Bridge.[9]

Repair and Maintenance

Aurora Avenue and the George Washington Memorial Bridge were instantly popular with local and through traffic. Within a month after the bridge opened, an average of over 11,000 vehicles per day crossed it, with a peak of over 1,500 during the hour from 5 to 6 p.m. By 1981, with Interstate 5 carrying most through traffic, it still averaged 54,200 a day during midweek. The bridge has been heavily used throughout its existence.[10]

Regular appraisals of the bridge's structural integrity through several decades revealed continuous gradual deterioration, but its extent was unknown until equipment was available to inspectors for viewing far reaching portions of the structure. Prior to the early 1990s, the only visual inspection of the deck's underside, including beams and stringers was accomplished by viewing them from the truss's lower chord. Only by using lift booms and buckets did inspectors gain a close-up view of these members.[11]

The Aurora Avenue Bridge has several weakened structural components that needed conservation and restoration. Of these, the most pressing were those attributable to iron oxidation. They include severe section loss in deck stringers, beams, and in sidewalk frames, and deterioration of rocker nests. Proposed repair activities for the Washington State Department of Transportation for the 1993-95 biennium include an estimated $1 million in refurbishment to the Aurora Avenue Bridge. These include removing and replacing existing sidewalks and frames and replacing them with a new design that avoids the longitudinal-type joints that caused water leakage and critical section loss in the past. Other refurbishment includes reinforcing top floor beam flanges and rebuilding rocker nests.[12]
For additional information and a comparative study of the evolution of cantilever design in Washington, see:

WASHINGTON KING COUNTY SEATTLE
WASHINGTON STATE CANTILEVER BRIDGES (HAER No. WA-106)

Data Limitations

Many research resources were available on the Aurora Avenue Bridge. Bridge files in the Bridge Preservation Section, Washington State Department of Transportation, in Olympia, were most useful in understanding the structure. An index for Seattle newspapers located at the Seattle Public Library was helpful in locating articles about the bridge's construction and dedication. Seattle newspapers are available in microfilm format at the

Washington State Library in Olympia. Finally, several articles in *Engineering News-Record* and *Western Construction News* described the techniques used in constructing the bridge.

The Washington State Historical Society in Tacoma has an extensive collection of Asahel Curtis photographs, including several large-format images of the bridge during and shortly after construction. Curtis was a well-known early twentieth-century regional photographer.

Project Information

This project is part of the Historic American Engineering Record (HAER), National Park Service. It is a long-range program to document historically significant engineering and industrial works in the United States.

The Washington State Historic Bridges Recording Project was co-sponsored in 1993 by HAER, the Washington State Department of Transportation (WSDOT), and the Washington State Office of Archeology & Historic Preservation. Fieldwork, measured drawings, historical reports, and photographs were prepared under the general direction of Robert J. Kapsch, Ph.D., Chief, HABS/HAER; Eric N. DeLony, Chief and Principal Architect, HAER; and Dean Herrin, Ph.D., HAER Staff Historian.

The recording team consisted of Karl W. Stumpf, Supervisory Architect (University of Illinois at Urbana-Champaign); Robert W. Hadlow, Ph.D., Supervisory Historian (Washington State University); Vivian Chi (University of Maryland); Erin M. Doherty (Miami University), Catherine I. Kudlik (The Catholic University of America), and Wolfgang G. Mayr (U.S./International Council on Monuments and Sites/Technical University of Vienna), Architectural Technicians; Jonathan Clarke (ICOMOS/Ironbridge Institute, England) and Wm. Michael Lawrence (University of Illinois at Urbana-Champaign), Historians; and Jet Lowe (Washington, D.C.), HAER Photographer.

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ENDNOTES

[1] Don Duncan, "Aurora Bridge: It Was a Big Day of Fanfare 50 Years Ago Today," *Seattle Times*, 22 February 1982, p. C-1; "Crowds at Bridge Dedication Honor First President," *Seattle Times*, 23 February 1932, 5.

[2] Trudy Weckworth, "The Aurora Avenue Bridge Turns 50 or The Day Milton Stapp Led the Way," *Fremont Forum*, December 1981, n.p.; T. G. McCrory, "Lake Union Bridge Completed," *Civil Engineering* 1 (September 1931): 1092-94.

[3] T. G. McCrory, "Lake Union Bridge Completed," *Civil Engineering* 1 (September 1931): 1092-94; "Lake Union Bridge Provides New Traffic Ling in Seattle," *Engineering News-Record* 108 (3 March 1932): 313.

[4] McCrory, "Lake Union Bridge Completed," 1092-94; "Lake Union Bridge, Seattle, Washington," *Western Construction News*, (10 May 1930): 226-27; "Approval of Location and Plans of Bridge, September 1929," in "Aurora Avenue Bridge, No. 99/560," in Correspondence Files, Bridge Preservation Section, Washington State Department of Transportation, Olympia, WA [WSDOT].

[5] "Aurora Avenue Bridge, No. 99/560," Kardex Card File, Bridge Preservation Section, Washington State Department of Transportation, Olympia, WA; McCrory, "Lake Union Bridge Completed," 1092-94; "Lake Union Bridge, Seattle, Washington," 228.

[6] "Lake Union Bridge, Seattle, Washington," 227; Washington, Department of Highways, *Report of the Director of Highways, 1929-1931*, 20.

[7] "Lake Union Bridge, Seattle, Washington," 227; for a discussion of substructure construction see, F. W. Crocker, "Construction Problems of Lake Union Bridge Substructure," *Western Construction News* (10 May 1930): 228-32; "Lake Union Bridge Provides New Traffic Link in Seattle," *Engineering News-Record* 108 (3 March 1932): 313. Anchor arm piers used semi-circular arched web walls.

[8] McCrory, "Lake Union Bridge Completed," 1092-94; "Lake Union Bridge Provides New Traffic Link in Seattle, 313.

[9] Weckworth, "The Aurora Bridge Turns 50 or The Day Milton Stapp Led the Way," n.p. As Seattle's tallest bridge, the structure is also known by the name "Jumpers' Bridge." During its first fifty years, at least 146 people have leapt to their deaths from the deck. See Duncan, "Aurora Bridge: It was a Big Day of Fanfare 50 Years Ago Today," p. C-1.

[10] Duncan, "Aurora Bridge: It was a Big Day of Fanfare 50 Years Ago Today," p. C-1.

[11] "Aurora Avenue Bridge, No. 99/560," Bridge Inspection Reports, 1991-92, in Correspondence Files, Bridge Preservation Section, WSDOT.

[12] "Bridge Inspection Reports, 1991-92"; "Major Bridge Repairs, District 1, Program H--Non-Interstate Bridges, Proposed Activities, 1993-95," in "Aurora Avenue Bridge, No. 99/560," in Correspondence Files, Bridge Preservation Section, WSDOT.